7.0 HOOD CANAL SUMMER CHUM SALMON (HCSCS) ESU

7.1 BACKGROUND

7.1.1 Description of the ESU

The Hood Canal summer chum salmon ESU includes all naturally spawned chum salmon residing below impassable natural barriers (e.g., long-standing natural waterfalls) in the Hood Canal and eastern Strait of Juan de Fuca regions of Washington State, extending to the Dungeness River (Figure 1). The ESU has two geographically distinct regions: the Strait of Juan de Fuca and Hood Canal. Although the populations all share similar life history traits, the summer chum populations in the two regions are affected by different environmental and harvest impacts and display varying survival patterns and stock status trends (WDFW and PNPTT 2000).

Of the sixteen populations of summer chum salmon identified in this ESU, seven are considered to be "functionally extinct," and those are the Skokomish, Finch Creek, Anderson, Dewatto, Tahuya, Big Beef, and Chimacum (WDFW and PNPTT 2000; NMFS 2003). The remaining nine populations are well distributed throughout the ESU, except for the eastern side of Hood Canal: Quilcene, Dosewallips, Duckabush, Hamma Hamma, Lilliwaup, Union, Salmon/Snow, Jimmycomelately, and Dungeness. Fish from the following integrated artificial propagation programs are no more than moderately diverged from these populations and are included as part of the ESU: Quilcene National Fish Hatchery (NFH); Hamma Hamma Fish Hatchery (FH); Lilliwaup FH; Union/Tahuya FH; Big Beef Creek FH; Chimacum FH; Salmon Creek FH; and Jimmycomelately FH (SSHAG 2003). These hatchery-origin summer chum salmon populations are identified in Table 7.1 with the independent natural summer chum populations with which they are integrated.

7.1.2 Status of the ESU

In their most recent review of the ESA status of the Hood Canal summer chum salmon ESU, the majority of BRT members found that the ESU remains "likely to become endangered" in status (NMFS 2003). General "Viable Salmonid Population" (VSP) parameter findings, as per NMFS (2000), for the naturally spawning populations within the ESU were provided in the updated BRT status review document. In summary, the BRT found moderately high risks for the summer chum salmon ESU in all VSP elements.

The BRT expressed concern about the past extirpation of seven of the sixteen historical populations in the ESU and about the fact that most of the population losses occurred on the eastern side of Hood Canal (BRT 2003). The BRT acknowledged that, although many of the extant populations remain at very depressed abundance levels, adult returns in a number of streams increased in 2001 and 2002. The BRT remained concerned that widespread loss of estuary and lower floodplain habitat is an ongoing risk factor for the ESU.

The Puget Sound Technical Recovery Team (TRT) has not yet completed reviews to identify populations within the Hood Canal summer chum ESU and determine the levels of population

abundance, diversity, spatial structure and productivity necessary for ESU viability. Based on a preliminary analysis of genetic data conducted to identify populations, the TRT proposed that summer chum in the ESU appear to be a single meta-population, with the amount of long-term demographic exchange between spawning aggregations determined largely by geographical separation (K. Currens, NWIFC, pers. comm., February, 2004). The data suggest that the distinctiveness of Strait of Juan de Fuca and Hood Canal aggregations, which has been observed in other analyses, may be an artifact of recent extinctions and lack of genetic data for those extinct populations.

7.2 ASSESSMENT OF THE HATCHERY PROGRAMS

7.2.1 Broodstock History

There are eight hatchery broodstocks included in the ESU because they are integrated with natural summer chum salmon populations (Table 7.1).

Table 7.1. Independent natural Hood Canal summer chum salmon populations (WDFW and PNPTT 2000) and their relationship to Hood Canal summer chum salmon hatchery populations.

Independent Populations	Integrated Hatchery Populations
Quilcene	(1) Quilcene NFH, (2) Big Beef Creek FH
Dosewallips	None
Duckabush	None
Hamma Hamma	(3) Hamma Hamma River FH
Lilliwaup	(4) Lilliwaup Creek FH
Union	(5) Union River FH/Tahuya River FH
Salmon/Snow	(8) Salmon Creek FH, (7) Chimacum Creek FH
Jimmycomelately	(8) Jimmycomelately FH
Dungeness	None

There are no summer chum hatchery broodstocks propagated through WDFW and USFWS programs that are isolated from natural populations. Six hatchery populations are propagated to supplement the natural populations native to the watersheds where the hatcheries are located, and all of the hatchery populations are derived from and incorporate natural fish (Table 7.2). Two programs are reintroduction programs using transplanted summer chum stock. Broodstock serving as donor stock for these programs are derived from an aggregate of natural and hatchery-origin summer chum salmon.

There are no hatchery programs operating within the ESU that use fish collected from multiple areas or streams for broodstock.

Table 7.2. Hood Canal summer chum salmon hatchery propagation inventory. ESU, natural population integration, and production statuses for summer chum salmon hatchery programs located within the geographical boundaries of the Hood Canal summer chum salmon ESU.

HGMP Name	Program Type and Purpose	ESU Status	Program Description	Program Size (Max. release/yr)	Years in Operation
Hood Canal region					
Quilcene NFH	Integrated Conservation/ Reintroduction	In	Fed fry	389,000	12 *
Hamma Hamma FH	Integrated Conservation	In	Fed fry	802,000	7
Lilliwaup FH	Integrated Conservation	In	Fed fry	376,000	12 *
Union/Tahuya	Integrated Conservation/ Reintroduction	In	Fed fry	86,000 (Union) 352,000 (Tahuya)	4 1
Big Beef Creek FH	Reintroduction	In	Fed fry	86,000	9
Strait of Juan de Fuca					
Salmon Creek FH	Integrated Conservation/ Reintroduction	In	Fed fry	86,000	12 *
Chimacum Creek FH	Reintroduction	In	Fed fry	123,000	9
Jimmycomelately FH	Integrated Conservation	In	Fed fry	86,000	6

* The Quilcene NFH and Salmon Creek FH programs were terminated after the release of 2003 brood year summer chum in spring, 2004. Under the Summer Chum Salmon Conservation Initiative, summer chum hatchery programs are limited to a 12-year duration to reduce the risk of within-population genetic diversity reduction effects (WDFW and PNPTT 2003). The Lilliwaup program may be continued beyond the 12-year limit, due to the continued critically low abundance status of summer chum escapements to the watershed (WDFW and PNPTT 2003a).

7.2.2 Similarity between hatchery-origin and natural-origin fish

There are currently no specific genetic data yet available comparing hatchery-origin fish produced by the eight summer chum programs with natural-origin fish of the same populations. WDFW and the Point No Point Treaty Tribes are continuing to collect GSI allozyme and DNA samples from summer chum spawners through the ESU. The Co-managers plan to analyze collected data, allowing for comparisons of recent and past GSI results in future years. Their objective is to monitor genetic changes (e.g., changes in allelic characteristics) and to assess whether the supplementation programs have negatively affected the genetic diversity of the natural populations (WDFW and PNPTT 2000).

Although specific genetic data are lacking, there is no indication that summer chum salmon produced in the eight hatchery programs identified in Table 7.1 have diverged from the natural summer chum salmon genotype that served as donors for the hatchery programs. The hatchery programs have relied on the collection of broodstock directly from the natural summer chum salmon populations returning to each watershed. Analyses of allozyme collections made pre- and post-supplementation indicate that the natural summer chum salmon populations that are the subject of the supplementation hatchery programs have remained significantly different from

each other (LeClair 1998a; 1998b; 1998c; Kassler and Shaklee 2003). To reduce the likelihood for genetic divergence from the donor natural populations while summer chum are under artificial propagation, operation of the programs is limited to 12 years or three chum salmon generations. The 12-year program limit is applied to minimize the likelihood for deleterious genetic changes in the donor natural summer chum populations. A three-generation limit is intended to address the concern that repeated enhancement of the same population segment will result in a decrease in effective population size of the target population. It also limits to a few generations the exposure of natural fish to potentially deleterious selective effects of hatchery conditions, minimizing the likelihood for divergence between hatchery and natural-origin fish within the supplemented stock.

The eight summer chum hatchery programs identified in Table 7.1 are operated to fully integrate adults produced through the programs into the total natural spawning populations. Broodstock collected for each program are an aggregate of natural and hatchery-origin fish, and mating protocols are designed to maximize the effective breeding population size. Again, allozyme analyses conducted pre- and post-supplementation indicate that the natural summer chum salmon populations that are the subject of the supplementation hatchery programs have remained significantly different from each other (Kassler and Shaklee, 2003). The summer chum supplementation programs were implemented as a conservation response for populations that had been identified as at moderate or high risk of extinction (WDFW and PNPTT 2000). The supplementation programs have bolstered total population sizes (WDFW and PNPTT 2003) and likely have prevented deleterious small population effects to the genetic diversity of several stocks. Spawner survey data had indicated that two to three brood years in most populations had decreased to fewer than 50 fish, in particular for the Lilliwaup, Jimmycomelately, and Quilcene stocks (WDFW and PNPTT 2000). Natural population extirpation and loss of total ESU diversity were likely prevented through implementation of the Lilliwaup, Jimmycomelately, and Quilcene hatchery programs.

Hatchery-origin and natural-origin summer chum salmon share identical life history characteristics for the majority of the natural chum salmon life cycle, including seaward emigration and natural rearing during the pelagic fry stage in Hood Canal and the eastern Strait of Juan de Fuca; emigration and rearing northward to the southern Gulf of Alaska; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters; migration through Alaskan, British Columbian, and into Washington marine waters as maturing two- to five-year-old adults in July and August; and freshwater entry and spawning in natural summer chum areas in late August, September, and early October (WDFW and PNPTT 2000).

Life history characteristic differences are that the hatchery-origin fish produced by the eight programs are artificially spawned, incubated in a hatchery, and released as fed fry at an advanced size relative to natural-origin summer chum (1 gram average size versus 0.4 gram average for wild fry). Eggs are artificially fertilized and incubated in a hatchery under controlled conditions rather than being deposited in gravel reaches in the natural environment. Juvenile hatchery summer chum are fed an artificial diet prior to their release and migration into marine waters, whereas naturally produced fry emigrate seaward directly after emerging from the gravel. However, the hatchery-origin juveniles are released during the March-April period when natural-

origin fry are emigrating seaward.

7.2.3 Program Design

The eight hatchery programs identified in Table 7.1 are specifically designed to seed habitat using juveniles and adults for natural production purposes (WDFW and PNPTT 2000). The objective of six of the hatchery programs is to supplement and preserve at-risk natural summer chum populations, increasing their abundance over 12 years to levels where the populations are at low risk of extinction. The remaining two programs are reintroducing naturally spawning summer chum salmon adult populations into watersheds where the native populations had been extirpated. The eight programs have been successful in increasing the number of naturally spawning summer chum salmon in each watershed where the programs are located (WDFW and PNPTT 2003; NMFS 2002).

Summer chum salmon adults originating from the reintroduction programs have made up more than 50 percent of the total naturally spawning populations in Big Beef Creek and Chimacum Creek since the first returns from the programs in 1999. The poor abundance status of the population and the allowance for up to 100 percent of the returning population to be used as broodstock makes it likely that hatchery fish will make up a large portion of the total naturally spawning population in Jimmycomelately Creek. Otolith mark recovery data for the Jimmycomelately population in 2002 indicate that Jimmycomelately hatchery-origin fish made up 97 percent of the total natural escapement.

From 1997 to 2002, hatchery-origin summer chum salmon produced by the Salmon Creek Hatchery program made up an average of 44 percent (ranging from 8 to 73 percent) of the total Salmon/Snow naturally spawning population (WDFW and PNPTT 2003). Mark recovery analyses of Big Quilcene summer chum salmon returns in 2001 and 2002 indicate that Quilcene NFH-origin summer chum salmon made up an average of 47 percent of the total summer chum return to the river (adipose fin clip expanded recovery data from WDFW and PNPTT 2003). Otolith mark recovery data for the Hamma Hamma population in 2000-2002 indicates that Hamma Hamma hatchery-origin fish make up an annual average of 18 percent of the total natural escapement (ranging from 0 to 48 percent). Otolith mark recovery data for the Lilliwaup population in 2000-2002 indicates that Lilliwaup hatchery-origin fish made up an annual average of 36 percent of the total natural escapement (ranging from 0 to 80 percent). Preliminary results of otolith mark evaluations for a return of 1,916 summer chum adults to the Union River in 2003 indicates that over 80 percent of the total return was natural-origin fish (T. Johnson, WDFW, pers. comm., April, 2004).

The eight summer chum salmon hatchery programs operating within the ESU are designed to be integrated with the natural populations within each watershed. They are also designed to be isolated from each other (with the exception of the two reintroduction programs), in order to maintain among-population diversity within the ESU.

Mass marking of hatchery summer chum with adipose fin clips or otolith marks has allowed for assessments to be made of stray levels of hatchery fish to watersheds outside of the juvenile fish

release sites. Most supplementation programs adults have been recovered in the watershed where they were originally planted (WDFW and PNPTT 2003). For example, in 2002, 79 to 100 percent (95 percent for all summer chum streams combined) of adults unmarked or otolith-marked as supplementation fish were recovered in the same watershed to which they had been released as juveniles (WDFW and PNPTT 2003). The natural stray rate for Hood Canal summer chum salmon populations is unknown. However, a portion of the annual hatchery-origin adult returns were also recovered in other streams in 2000, 2001, and 2004. Quilcene NFH, Lilliwaup FH, Hamma Hamma FH, Salmon Creek FH, and Big Beef Creek FH have produced adult summer chum salmon that have strayed to other watersheds at levels higher than 5 percent of the total number of naturally spawning fish (data from WDFW and PNPTT 2003).

All summer chum salmon hatchery programs operating within the Hood Canal summer chum salmon ESU are "integrated" programs. Best management practices are applied in implementation of the programs, consistent with measures defined in the *Summer Chum Salmon Conservation Initiative* (SCSCI - WDFW and PNPTT 2000) and with measures described in Appendix A. Eight HGMPs containing conservation measures included in the SCSCI were assembled by the Co-managers to describe and guide summer chum artificial propagation actions (WDFW 2000a, 2000b, 2000c, 2000d, 2000e; LLTK 1999a, 1999b; USFWS 2000). Specific measures are implemented through the HGMPs to minimize adverse genetic, ecological, and demographic effects on listed fish. The individual plans describe hatchery fish production, monitoring and evaluation, and research components of each program. The eight HGMPs were submitted to NMFS in 1999 and 2000 by WDFW and USFWS for an evaluation and determination as to whether the plans addressed criteria under the ESA 4(d) Rule Limit 5, allowing exceptions to take prohibitions for listed summer chum salmon defined in Section 9 of the ESA. NMFS evaluated the HGMPs and found in March 2002 that they adequately addressed all of the criteria specified in Limit 5 of the ESA 4(d) Rule. The summer chum programs have operated under the approved HGMPs since that time.

Sections 6, 7, 8, and 9 of the HGMPs describe broodstock selection, collection, mating, and juvenile fish rearing measures that will be applied to minimize the risk of within- and among-population diversity loss to the donor and to artificially propagated summer chum salmon populations. These measures and risk avoidance protocols for protecting genetic diversity are thoroughly described and reviewed in the ESA section 7 biological opinion completed for hatchery programs within the listed summer chum salmon ESU (NMFS 2001). Measures implemented to minimize ecological effects on listed natural populations are described in sections 7.7, 9.3, 9.16, 9.17, 9.27, 10.9, and 11.1 of each HGMP. The hatchery program operators comply with the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998), including referenced American Fisheries Society "Blue Book" and WDFW "Fish Health Manual" protocols, in all phases of the programs to limit disease risks to natural populations. The program should be adequately protective of listed summer chum through application of these disease control measures. The effects of competition are minimized through criteria governing fish size and area of release in section 10 of the HGMPs. Juvenile hatchery summer chum salmon are purposely released during the normal emigration periods for the natural populations as a measure to mimic natural population life history strategy. However, the release of fed fry of approximately one gram size (~56 mm

fork length) through the supplementation programs should limit interaction and adverse competitive effects between hatchery-origin summer chum and natural-origin chum post-release due to marine area habitat preference and migratory behavioral differences. Due to similar fish size and non-piscivorus life history characteristics of co-emigrating juvenile hatchery- and natural-origin summer chum salmon, predation by hatchery summer chum is not a risk factor for natural-origin fish. Finally, each HGMP includes monitoring and evaluation measures designed to collect data that will identify whether the program is leading to ecological or genetic changes in the natural populations. Protocols are in place to adjust or terminate the programs in the event that adverse changes in the character or productivity of the donor natural summer chum population result from implementation of the HGMPs.

Each of the eight summer chum salmon hatchery programs identified in Table 7.1 mark 100 percent of the juvenile fish released each year. Summer chum salmon released through the Quilcene NFH program have been mass marked with an adipose fin clips. Summer chum released through the seven other programs have been mass marked through application of a thermally induced otolith mark that is specific to each release site (WDFW and PNPTT 2000, 2003).

7.2.4 Program Performance

Mark recovery surveys for otolith marked and adipose fin clipped summer chum salmon adults in 2000, 2001, and 2002 indicate that Quilcene NFH, Salmon Creek FH, and, Big Beef Creek FH have had stray rates in one or more years exceeding 10 percent of the total abundance of the receiving population into which the hatchery fish have strayed (data from WDFW and PNPTT 2003).

Under the SCSCI, a fry-to-adult survival rate range of 0.83 to 1.66 percent was set as an objective for each supplementation and reintroduction program (WDFW and PNPTT 2000). Data collected by USFWS and WDFW on mark recovery and age class at return indicate that fry-to-adult survival rates are at the lower end or below this range for the Quilcene NFH program (Table 7.3).

Analyses of otolith mark recovery data for the Salmon Creek program indicates a six brood-year (1994-1999) average juvenile hatchery fish release-to-adult return survival rate of 2.3 percent (ranging from 0.62 to 4.8 percent) (Table 7.4 - data from WDFW and PNPTT 2003).

Fry-to-escaping-adult survival rate estimates are available for three complete brood years (1996-98) for hatchery summer chum salmon released through the Chimacum Creek reintroduction program. Estimated survival rates were 0.1 percent, 1.22 percent, and 1.29 percent for brood years 1996, 1997, and 1998, respectively, based on otolith mark recovery data (WDFW and PNPTT 2003a).

Table 7.3. Fry to adult survival to escapement estimates based on adipose fin clip recoveries for summer chum salmon produced through the Quilcene NFH supplementation program.

Brood Year	Total Brood Year Fry Release	Resultant Hatchery-origin 3-year-old Return	Resultant Hatchery-origin 4-year-old Return	Resultant Hatchery-origin 5-year-old Return	Fry to Adult Survival (estimated percent)
1997	340,744	394	1,919	25	0.69
1998	343,530	1,399	452	2	0.54
1999	181,711	1,266	605	N/A	1.03 *
2000	414,353	1,634	N/A	N/A	0.39 *

* Survival estimates lack complete brood year age class contribution data - to be collected in 2003-2005.

Table 7.4. Fry to adult survival to escapement estimates based on otolith mark recoveries for summer chum salmon produced through the Salmon Creek FH supplementation program.

Brood Year	Total Brood Year Fry Release	Resultant Hatchery-origin 2-year-old Return	Resultant Hatchery-origin 3-year-old Return	Resultant Hatchery-origin 4-year-old Return	Resultant Hatchery-origin 5-year-old Return	Fry-to-adult Survival (estimated percent)
1994	2,000	0	46	50	0	4.8
1995	38,800	13	471	148	5	1.6
1996	62,000	8	219	162	0	0.6
1997	71,800	0	231	727	0	1.5
1998	67,800	14	698	709	N/A	2.1 *
1999	34,680	39	1,078	N/A	N/A	3.2 *

* Survival estimates lack complete brood year age class contribution data - to be collected in 2003-05.

Release to return survival rates, based on mark recovery data, have not yet been derived for the five other summer chum salmon hatchery programs identified in Table 7.1. Included among these programs are the Lilliwaup FH and Jimmycomelately FH programs. These two programs have had improved total spawner abundances since their initiation (WDFW and PNPTT 2000; WDFW and PNPTT 2003; Ames, 2003) and have likely helped prevent extirpation of the supplemented populations, which were critically depressed in status. Adult returns to Big Beef Creek and Chimacum Creek in recent years are entirely attributable to the two reintroduction programs active in the watersheds. Juvenile hatchery fish releases through the reintroduction efforts have resulted in combined adult returns into the two watersheds exceeding total summer chum spawner abundances observed for the entire ESU in the early 1990s.

Preliminary mark recovery and age class data indicates that the progeny of naturally spawning Quilcene NFH and Salmon Creek FH summer chum, and natural-origin summer chum that are mainly progeny of naturally spawning hatchery fish, are producing recruits at variable rates.

Available data suggests that the aggregate naturally spawning population is reproducing below the replacement level for some brood years, whereas data for other years indicates natural productivity within ranges observed for wild chum salmon populations in the Pacific Northwest and Southeast Alaska regions. Bakkala (1970) reported recruit per spawner rates for natural-origin chum salmon populations in British Columbia and Southeastern Alaska ranging from 0.6 to 13.2. Included in the Co-managers ' "Interim Recovery Goal" for individual stocks comprising the summer chum ESU is a requirement that natural recruits per spawner average at least 1.6 over the most recent eight brood years for which estimates exist, and that no more than two of the eight years will fall below 1.2 recruits per spawner (WDFW and PNPTT 2003b).

All juvenile chum salmon released through the Quilcene NFH program have been mass-marked with an adipose fin clip since the 1997 brood year. As of 2003, mass-marked hatchery-origin summer chum adults have returned to the Big Quilcene River for two complete chum brood cycles (3-, 4-, and 5-year-old adult fish produced by naturally spawning fish in 1997 and 1998). Mark recovery, scale analysis, and spawner abundance data for these complete brood years allow for natural recruit per spawner to be made (Table 7.5). Hatchery and natural-origin spawners in the Big Quilcene River for brood years 1998 and 1999 had estimated recruit per spawner rates of 0.39 and 0.26, respectively. Salmon Creek FH summer chum have been marked with an otolith mark since the 1993 brood year, and estimated recruit-per-spawner data are available for four complete brood years (1994-1997) (Table 7.6). Recruit-per-spawner estimates ranged from 0.2 to 6.5 for these brood years.

Table 7.5. Recruit per spawner estimates for hatchery and natural-origin summer chum salmon that spawned in the Big Quilcene River in 1998 and 1999 (data from Tom Kane, USFWS, Lacey, WA, March, 2004).

Brood Year	Brood Year Natural Escapement *	Resultant Natural-origin 3-year-old Escapement	Resultant Natural-origin 4-year-old Escapement	Resultant Natural-origin 5-year-old Escapement	Recruit-per-spawner Estimate
1997	7,339	299	2,436	88	0.39
1998	2,244	317	212	58	0.26
1999	2,892	1,983	2,735	NA	1.63 **
2000	5,126	6,800	NA	NA	1.33 **

* Total natural spawning escapement of the Big Quilcene River, excluding broodstock removals.
** Recruit per spawner estimates lack complete brood year age class contribution data - to be collected in 2004-05.

Table 7.6. Recruit per spawner estimates for hatchery and natural-origin summer chum salmon that spawned in Salmon Creek (data from WDFW and PNPTT 2003).

Brood Year	Brood Year Natural Escapement *	Resultant Natural-origin 2-year-old Escapement	Resultant Natural-origin 3-year-old Escapement	Resultant Natural-origin 4-year-old Escapement	Resultant Natural-origin 5-year-old Escapement	Total Recruit-per-spawner Estimate
1994	137	-	490	396	5	6.5
1995	538	17	209	49	4	0.5
1996	785	0	63	83	0	0.2
1997	724	0	315	670	12	1.4
1998	1,023	37	427	510	**	1.0 **
1999	434	77	3208	**	**	7.7 **

* Total natural spawning escapement to Salmon Creek, excluding broodstock removals.
** Recruit per spawner estimates lack complete brood year age class contribution data - to be collected in 2004 and 2005.

Recruit-per-spawner rates have not yet been derived for naturally spawning summer chum salmon populations associated with the summer chum salmon hatchery programs identified in Table 7.1, except for the Quilcene and Salmon/Snow populations.

Each hatchery program is limited to a12-year duration to minimize the likelihood for deleterious genetic changes in the donor natural summer chum populations. Two of the eight programs reached the 12-year operation limit in 2004 and were terminated. Continuation of the remaining six programs through their 12-year limit of operation is very certain, given the conservation intent of the programs and their alignment with the SCSCI, the Co-managers ' consensus recovery initiative for the ESU. The programs are supported and funded by a variety of sources, including WDFW, USFWS, and several private, non-governmental cooperative groups that have a strong commitment to summer salmon recovery in local watersheds. Each program is approved under the ESA and NEPA for their 12year duration of operation, and all other state permits needed for their continued operation are in hand.

None of the summer chum salmon hatchery programs block or hinder juvenile summer chum salmon migration or distribution. The only hatchery program that blocks adult summer chum migration and distribution is the Quilcene NFH program, which operates a permanent dam and electric weir that is an impassable barrier to upstream fish migration at river mile 2.8. The Hamma Hamma program does not employ a weir or trap to collect broodstock, and summer chum adult migration and distribution are not affected by the program. The remaining four hatchery programs hinder adult migration and distribution through delay of upstream migrating spawners at temporary broodstock collection weirs positioned in the lower portion of the watersheds. The two reintroduction programs active in the ESU have benefited summer chum migration and distribution by re-establishing adult returns to watersheds where summer chum have not spawned for decades. Several of the supplementation programs have benefited the spatial structure of the populations by increasing naturally spawning summer chum abundances in underutilized spawning areas (e.g., Big Quilcene River, Salmon Creek).

All of the summer chum hatchery programs operate water diversions that are properly screened and in compliance with NMFS screening criteria (NMFS 1995, 1996; NMFS 2001).

7.2.5 VSP Effects

Following is a summarized assessment of VSP parameter effects of all eight summer chum salmon hatchery programs active within the ESU. A VSP assessment for the individual hatchery programs is provided in the matrix in Appendix A.

Abundance - Data indicate that the eight summer chum salmon hatchery programs are increasing the abundance of naturally spawning summer chum salmon for the target populations (WDFW and PNPTT 2000, 2003a; Ames 2003). Spawner escapement trends for all of the supplemented populations have been positive since the initial adult returns resulting from each program. Two of the programs (Lilliwaup and Jimmycomelately) have likely prevented further extirpations of two extant populations that were critically depressed in abundance prior to initiation of the programs. Effects of the programs on natural-origin summer chum spawner abundance is uncertain. All of the hatchery programs are relatively new (initiated in or after 1992), and more data are needed to indicate their effects on natural spawner abundance. In particular, the post-supplementation effects of the programs on natural spawner abundance must be evaluated to determine whether the hatchery actions have helped lead to self-sustaining natural populations. It is important to recognize that the hatchery programs cannot resurrect seven summer chum salmon populations that were extirpated in recent years. Two of the programs have successfully reintroduced naturally spawning summer chum to two watersheds (Big Beef Creek and Chimacum Creek), and a third (Tahuya River) was planted with transplanted summer chum juveniles in 2004. As previously noted, all of the hatchery programs terminate after 12 years of operation. Two reached their operational limit in spring 2004 (Quilcene NFH and Salmon Creek FH), and both have been terminated. Naturally producing summer chum populations must sustain abundances within the ESU in future years without assistance from the hatchery programs.

Productivity - Summer chum salmon hatchery program effects on the productivity of the naturally spawning summer chum salmon populations remain uncertain and, given the intent to terminate all of the hatchery programs after 12 years, depend on the preservation and restoration of properly functioning habitat. Estimated recruit-per-spawner data indicate that the natural productivity of the Quilcene and Salmon/Snow populations has been below replacement for some brood years and at or well above replacement for other brood years coincident with supplementation. Productivity levels for natural summer chum populations after termination of the hatchery programs needs to be evaluated. Monitoring and evaluation necessary to track natural spawner productivity is being implemented (WDFW and PNPTT 2000; 2003a). The two reintroduction programs that have been active since 1996 are leading to natural spawning in tributaries where no spawning had occurred for 20 years, expanding previously lost productivity resulting from extirpations. A third reintroduction program on the Tahuya River initiated in 2004 is expected to resurrect production in one more watershed where the native population had become extirpated. Recent-year program monitoring indicates hatchery fry-to-adult survival rates approaching or exceeding WDFW and PNPTT (2000) expectations, indicating that the hatchery

programs themselves are benefiting ESU productivity.

Spatial Structure - Several of the six supplementation programs are benefiting spatial structure of summer chum salmon populations within their native watersheds by expanded spawning area use in response to increased spawner abundances and densities. Two reintroduction programs are leading to natural spawning in previously barren summer chum streams, and are serving as range extensions for two extant populations (Quilcene and Salmon/Snow). All of the supplementation programs were initiated in response to high or moderate extinction risks identified for the target natural populations. The programs have likely prevented further summer chum population extirpations and loss of extant spatial structure within the ESU.

Diversity - The summer chum supplementation programs were implemented as conservation responses for populations that had been identified as at moderate or high risk of extinction (WDFW and PNPTT 2000). The supplementation programs have bolstered total population sizes (WDFW and PNPTT 2003a) and likely have avoided genetic diversity loss in several smaller populations. Spawner survey data had indicated that two to three brood years in most populations had decreased to fewer than 50 fish, and in some cases fewer than 25 (WDFW and PNPTT 2000). Natural population extirpation and loss of total ESU diversity were likely prevented by the Lilliwaup, Jimmycomelately, and Quilcene hatchery programs. Reintroductions of spawning summer chum populations in Big Beef Creek and Chimacum Creek and in the Tahuya River (beginning in 2006) serve as genetic reserves for the donor Quilcene, Salmon/Snow, and Union populations. Measures are applied to maintain genetic diversity, including a 12-year limit on program duration, use of native stocks for supplementation, and application of appropriate hatchery brood collection and mating protocols (WDFW and PNPTT 2000). These measures appear to have been effective in maintaining extant diversity of populations within the ESU coincident with supplementation actions (Kassler and Shaklee 2003).

Summary - The hatchery populations produced by the eight programs have benefited the abundance, diversity, and spatial structure of the Hood Canal summer chum ESU. Benefits afforded by the hatchery programs must be viewed as temporary, however, as all of the programs are scheduled to terminate after 12 years of operation, as a result of which two of the hatchery programs terminated operations in spring 2004. The viability of the ESU will therefore depend only on the survival and productivity of natural-origin summer chum populations in the short and long term. The hatchery programs and their effects cannot be viewed as sufficient to offset the "threatened" extinction risk assessed for the natural populations that make up the ESU.

Since their initiation in 1992, the Quilcene NFH, Salmon Creek, and Lilliwaup Creek programs have provided a substantial benefit to the preservation of the Quilcene and Snow/Salmon populations and have increased naturally spawning summer chum salmon abundances. The first two programs have further benefited naturally spawning summer chum abundances in the ESU through the reintroduction of summer chum populations in Big Beef Creek and Chimacum Creek The more recently initiated hatchery programs, the Hamma Hamma, Jimmycomelately, and Union summer chum, also are contributing to total adult returns. Hatchery program effects on the productivity of the natural summer chum populations are as yet unknown. Natural population recruit-per-spawner rates coincident with operation of the hatchery programs have been variable,

as have hatchery fry to adult survival rates for the programs. Monitoring of summer chum salmon population trends and reproductive success in years following the last hatchery-origin adult returns is needed to assess whether the natural populations are self-sustaining. The eight hatchery programs have benefited the diversity of the ESU by preserving populations threatened with extinction (preventing extirpations), bolstering total population sizes (retaining within-population genetic diversity), and creating genetic reserves (through reintroductions of transplanted stocks into historical summer chum streams where the native populations were extirpated). ESU spatial structure has benefited through summer chum spawning range extensions resulting from reintroduction efforts at Big Beef Creek, Chimacum Creek, and (in 2006) the Tahuya River. Increased summer chum spawner abundances and densities in supplemented watersheds have led to increased areal distribution of spawners in the Big Quilcene and Salmon Creek watersheds, relative to pre-supplementation years.

7.3 CONCLUSION

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

7.3.1. ESU Overview

7.3.1.1 History of Populations

An estimated 16 independent summer chum salmon populations were historically present in the Hood Canal summer salmon ESU (NMFS 2003). Of the 16 populations, nine remain extant, and seven are putatively extinct (NMFS 2003). Of the seven extinct summer chum salmon populations, four inhabited Hood Canal tributary streams clustered on the East Kitsap Peninsula.

Remaining populations are: Quilcene, Dosewallips, Duckabush, Hamma Hamma, Lilliwaup, Union, Salmon/Snow, Jimmycomelately, and Dungeness. Three of these populations, Quilcene, Union, and Salmon/Snow, serve as donor stocks for reintroductions of natural summer chum populations in watersheds where the native stocks had become extinct (Big Beef Creek, Tahuya River, and Chimacum Creek, respectively).

7.3.1.2 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

There are presently three listed natural populations in this ESU that are likely to be subject to minimal or less genetic influence from hatchery-origin fish. These three populations are: Dosewallips; Duckabush, and Dungeness. Hatchery programs that are specifically designed to supplement naturally spawning populations that were identified as at moderate or high risk of extinction (WDFW and PNPTT 2000) have a substantial genetic influence on each of the remaining six summer chum salmon populations in the ESU.

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]

The Quilcene, Dosewallips, Duckabush, Hamma Hamma, Lilliwaup, Union, and Salmon/Snow natural populations may be considered stable (as determined by short-term abundance trends and short term median populations growth rates equivalent to or exceeding 1.0 (NMFS 2003)), and spawning in the wild. However, with the exception of Quilcene, the long term abundance trends for these populations is less than 1.0 (NMFS 2003). The adequacy of spawning and rearing habitat for these summer chum populations is unknown, but the best available information indicates that freshwater habitat features essential for the viability of natural summer chum salmon populations has been degraded by human activities in all watersheds (WDFW and PNPTT 2000).

Mixed (Integrated Programs[c])

Mixed (aggregate natural and hatchery-origin) summer chum salmon populations in the ESU are: Quilcene, Hamma Hamma, Lilliwaup, Union, Big Beef Creek (reintroduced population), Salmon/Snow, Chimacum Creek (reintroduced population), and Jimmycomelately.

Hatchery (Isolated[d])

None.

7.3.2. Summary of ESU Viability

7.3.2.1 Abundance. Table 7.7 summarizes recent-year abundance information for extant populations within the ESU, including the estimated total number of naturally spawning fish and the number of within ESU hatchery-origin fish contributing to total natural spawning or escapement. Interim recovery abundance goals derived for each extant population (with the exception of Dungeness) by the Co-managers (WDFW and PNPTT 2003b) are included in Table 7.7 to provide perspective regarding the current abundance status of the natural and aggregate hatchery and natural populations. Estimated natural-origin returns and the total number of natural spawners (i.e., the combination of natural-origin and hatchery-origin summer chum salmon included in the ESU) have increased dramatically for most of the populations since 1999 when the ESU was listed as threatened. Average total (aggregate natural- and hatchery-origin summer chum salmon) escapements to natural spawning areas for the most recent five years are generally above interim recovery goals derived for each population that has been the subject of

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[a] See HLP for definition of natural, mixed and hatchery populations

[b] HLP Point 3

[c] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

supplementation actions (Table 7.7). Adult returns to Big Beef Creek and Chimacum Creek as a result of two population reintroduction programs have led to substantial adult returns to natural spawning areas where no fish had been present for two decades.

Effects of the hatchery programs on natural-origin summer chum salmon abundance are unknown. The hatchery programs are relatively new (the first two commenced in 1992) and evaluations of their effects in increasing the number of natural-origin fish are pending collection of additional data. Initial return of adult fish that are the progeny of naturally spawning hatchery fish are expected in 2004 in two watersheds where reintroduction programs operate. Monitoring of hatchery- and natural-origin adult return proportion in Big Beef Creek and Chimacum Creek will indicate program effects on natural-origin abundance. All of the hatchery programs are designed to terminate after 12 years as a risk reduction measure, so the programs cannot be relied on to sustain natural-origin abundances in future years.

7.3.2.2 Productivity. It is unknown whether naturally spawning summer chum salmon originating from the hatchery programs have affected the productivity of the natural populations. Recruit-per-spawner rates have not yet been derived for naturally spawning summer chum salmon populations associated with the summer chum salmon hatchery programs, other than for four brood years for the Quilcene and Salmon/Snow populations. The productivity of the naturally spawning Quilcene and Salmon/Snow summer chum populations (measured as recruits per spawner) has been variable, coincident with operation of the Big Quilcene NFH and Salmon Creek FH supplementation programs. Adult returns resulting from reintroduction programs in Big Beef Creek and Chimacum Creek have led to summer chum spawning in watersheds where summer chum productivity was absent for two decades. More data are needed, especially after the programs have been terminated, to determine their effects on natural-origin summer chum productivity and the sustainability of the natural populations under current natural habitat conditions.

Smolt-to-adult survival data indicate that nearly all of these integrated hatchery programs are self-sustaining and returning adult fish to the watersheds at a rate of 1.6 to 2.0 percent (data from WDFW and PNPTT 2003).

Table 7.7. Estimated number of natural-origin summer chum salmon included in the Hood Canal summer chum salmon ESU escaping to spawning grounds and the estimated number of hatchery-origin summer chum salmon included in the ESU escaping to spawning grounds and returning to hatcheries. Continued on next page.

	Skokomish			Tahuya			Union			Little Quilcene			Big Quilcene		
Return Year	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement
1974	N/A	0	N/A	880	0	880	68	0	68	44	0	44	795	0	795
1975	N/A	0	N/A	1,389	0	1,389	84	0	84	868	0	868	1,405	0	1,405
1976	N/A	0	N/A	3,200	0	3,200	100	0	100	1,088	0	1,088	2,445	0	2,445
1977	N/A	0	N/A	726	0	726	75	0	75	773	0	773	821	0	821
1978	N/A	0	N/A	266	0	266	64	0	64	1,816	0	1,816	2,978	0	2,978
1979	N/A	0	N/A	117	0	117	97	0	97	110	0	110	345	0	345
1980	N/A	0	N/A	179	0	179	208	0	208	154	0	154	375	0	375
1981	N/A	0	N/A	140	0	140	41	0	41	84	0	84	138	0	138
1982	N/A	0	N/A	86	0	86	153	0	153	125	0	125	156	0	156
1983	N/A	0	N/A	86	0	86	170	0	170	176	0	176	100	0	100
1984	N/A	0	N/A	142	0	142	194	0	194	83	0	83	60	0	60
1985	N/A	0	N/A	122	0	122	334	0	334	1	0	1	44	0	44
1986	N/A	0	N/A	109	0	109	1,892	0	1,892	12	0	12	15	0	15
1987	N/A	0	N/A	91	0	91	497	0	497	71	0	71	8	0	8
1988	N/A	0	N/A	145	0	145	629	0	629	177	0	177	120	0	120
1989	N/A	0	N/A	9	0	9	450	0	450	1	0	1	1	0	1
1990	N/A	0	N/A	6	0	6	275	0	275	0	0	0	6	0	6
1991	N/A	0	N/A	5	0	5	208	0	208	1	0	1	49	0	49
1992	N/A	0	N/A	0	0	0	140	0	140	9	0	9	743	0	743
1993	N/A	0	N/A	0	0	0	251	0	251	12	0	12	136	0	136
1994	N/A	0	N/A	0	0	0	738	0	738	0	0	0	722	0	722
1995	N/A	N/A	N/A	0	N/A	0	721	0	721	54	0	54	N/A	N/A	4,520
1996	N/A	N/A	N/A	5	N/A	5	494	0	494	265	0	265	N/A	N/A	9,250
1997	N/A	N/A	N/A	0	N/A	0	410	0	410	29	0	29	N/A	N/A	7,874
1998	N/A	N/A	N/A	0	N/A	0	223	0	223	265	0	265	N/A	N/A	2,792
1999	N/A	N/A	N/A	1	N/A	1	159	0	159	84	0	84	N/A	N/A	3,153
2000	N/A	N/A	N/A	2	N/A	2	744	0	744	254	14	268	N/A	N/A	5,630
2001	N/A	N/A	3	0	N/A	0	1,491	0	1,491	143	56	199	3,054	3120	6,174
2002	N/A	N/A	N/A	0	N/A	0	872	0	872	394	76	470	2,267	1750	4,017
2003	N/A	N/A	N/A	0	N/A	0	10,013	1,767	11,780	890	0	890	9,960	1,883	11,843
Interim Recovery Abundance Goal 1/			N/A			N/A			340			(see Big Quilcene)			2860
All Years															
Arithmetic Means				257	0	257	727	59	785	266	5	271	1114	281	2,224
% Natural						100%			93%			98%			50%
% Hatchery						0%			7%			2%			13%
Mean % Goal						N/A			231%			N/A		Quilcene Comb	87%
Post Listing (1999-)															
Arithmetic Means							2656	353	3,009	353	29	382	5094	2251	6,163
% Natural									88%			92%			83%
% Hatchery									12%			8%			37%
Mean % Goal									885%			N/A		Quilcene Comb	229%

Notes: Total escapement data from Kyle Adicks, WDFW, May 26, 2004.

1/ Interim recovery abundance goal for natural-origin fish from WDFW and PNPTT 2003.

2/ Hatchery origin chinook escapement includes estimated escapement to natural spawning areas and escapement to hatcheries.

3/ Hatchery and natural summer chum escapement data from WDFW and PNPTT, 2003.

Table 7.7 (continued). Estimated number of natural-origin summer chum salmon included in the Hood Canal summer chum salmon ESU escaping to spawning grounds and the estimated number of hatchery-origin summer chum salmon included in the ESU escaping to spawning grounds and returning to hatcheries. Continued on next page.

	Big Beef Creek			Dosewallips			Duckabush			Hamma Hamma			Lilliwaup		
Return Year	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement
1974	75	0	75	3,593	0	3,593	3,581	0	3,581	2,448	0	2,448	616	0	616
1975	1,152	0	1,152	2,250	0	2,250	2,245	0	2,245	7,341	0	7,341	706	0	706
1976	1,281	0	1,281	3,271	0	3,271	6,095	0	6,095	7,648	0	7,648	1,612	0	1,612
1977	302	0	302	3,215	0	3,215	2,453	0	2,453	1,675	0	1,675	420	0	420
1978	680	0	680	1,901	0	1,901	1,898	0	1,898	8,215	0	8,215	1,331	0	1,331
1979	191	0	191	1,190	0	1,190	1,190	0	1,190	3,096	0	3,096	163	0	163
1980	123	0	123	1,216	0	1,216	827	0	827	329	0	329	247	0	247
1981	90	0	90	63	0	63	557	0	557	926	0	926	293	0	293
1982	0	0	0	507	0	507	690	0	690	801	0	801	84	0	84
1983	0	0	0	64	0	64	80	0	80	190	0	190	18	0	18
1984	22	0	22	212	0	212	299	0	299	170	0	170	187	0	187
1985	0	0	0	236	0	236	30	0	30	231	0	231	92	0	92
1986	0	0	0	57	0	57	177	0	177	173	0	173	97	0	97
1987	6	0	6	9	0	9	12	0	12	26	0	26	32	0	32
1988	0	0	0	661	0	661	497	0	497	440	0	440	275	0	275
1989	0	0	0	16	0	16	60	0	60	16	0	16	43	0	43
1990	0	0	0	8	0	8	42	0	42	90	0	90	2	0	2
1991	0	0	0	250	0	250	102	0	102	71	0	71	30	0	30
1992	0	0	0	655	0	655	617	0	617	123	0	123	99	0	99
1993	0	0	0	105	0	105	105	0	105	69	0	69	77	0	77
1994	0	0	0	225	0	225	263	0	263	370	0	370	111	0	111
1995	0	0	0	2,787	0	2,787	825	0	825	476	0	476	N/A	N/A	79
1996	0	0	0	6,976	0	6,976	2,650	0	2,650	774	0	774	N/A	N/A	76
1997	0	0	0	47	0	47	475	0	475	104	0	104	N/A	N/A	27
1998	0	0	0	336	0	336	226	0	226	127	0	127	N/A	N/A	24
1999	0	4	4	351	0	351	92	0	92	255	4	255	N/A	N/A	13
2000	0	20	20	1,260	0	1,260	464	0	464	219	10	229	18	4	22
2001	0	894	894	780	210	990	665	277	942	1,154	73	1,227	48	44	92
2002	0	742	742	1,332	295	1,627	356	174	530	1,038	1290	2,328	37	821	858
2003	0	896	896	N/A	N/A	7,066	N/A	N/A	1,869	N/A	N/A	2,328	N/A	N/A	353
Interim Recovery Abundance Goal			N/A			1930			2060			3790			1960
All Years															
Arithmetic Means	131	85	216	1158	17	1,175	951	16	966	1331	47	1,378	277	36	313
% Natural			61%			99%			98%			97%			88%
% Hatchery			39%			1%			2%			3%			12%
Mean % Goal			N/A			61%			47%			36%			16%
Post Listing (1999-)															
Arithmetic Means	0	511	511	931	126	1,057	394	113	507	667	344	1,010	34	290	324
% Natural			0%			88%			78%			66%			11%
% Hatchery			100%			12%			22%			34%			89%
Mean % Goal			N/A			55%			25%			27%			17%

Notes: Total escapement data from Kyle Adicks, WDFW, May 26, 2004.

1/ Interim recovery abundance goal for natural-origin fish from WDFW and PNPTT 2003.

2/ Hatchery origin chinook escapement includes estimated escapement to natural spawning areas and escapement to hatcheries.

3/ Hatchery and natural summer chum escapement data from WDFW and PNPTT, 2003.

Table 7.7 (continued). Estimated number of natural-origin summer chum salmon included in the Hood Canal summer chum salmon ESU escaping to spawning grounds and the estimated number of hatchery-origin summer chum salmon included in the ESU escaping to spawning grounds and returning to hatcheries.

	Dewatto			Chimacum			Snow			Salmon			Jimmycomelately		
Return Year	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement
1974	181	0	181	0	0		818	0	818	512	0	512	438	0	438
1975	613	0	613	0	0		340	0	340	755	0	755	353	0	353
1976	741	0	741	0	0		608	0	608	521	0	521	365	0	365
1977	225	0	225	0	0		538	0	538	701	0	701	405	0	405
1978	544	0	544	0	0		629	0	629	1,664	0	1,664	787	0	787
1979	49	0	49	0	0		133	0	133	458	0	458	170	0	170
1980	117	0	117	0	0		709	0	709	3,074	0	3,074	1,326	0	1,326
1981	41	0	41	0	0		242	0	242	439	0	439	203	0	203
1982	21	0	21	0	0		766	0	766	1,386	0	1,386	599	0	599
1983	15	0	15	0	0		154	0	154	731	0	731	254	0	254
1984	44	0	44	0	0		384	0	384	828	0	828	367	0	367
1985	19	0	19	0	0		20	0	20	151	0	151	61	0	61
1986	20	0	20	0	0		213	0	213	582	0	582	292	0	292
1987	5	0	5	0	0		465	0	465	1,062	0	1,062	464	0	464
1988	23	0	23	0	0		723	0	723	1,915	0	1,915	1,052	0	1,052
1989	2	0	2	0	0		21	0	21	194	0	194	173	0	173
1990	0	0	0	0	0		33	0	33	245	0	245	63	0	63
1991	31	0	31	0	0		12	0	12	172	0	172	125	0	125
1992	0	0	0	0	0	0	21	0	21	433	0	433	616	0	616
1993	1	0	1	0	0	0	11	0	11	452	0	452	110	0	110
1994	0	0	0	0	0	0	2	0	2	161	0	161	15	0	15
1995	0	0	0	0	0	0	25	0	25	591	0	591	223	0	223
1996	0	0	0	0	0	0	160	0	160	894	0	894	30	0	30
1997	6	0	6	0	0	0	67	0	67	768	66	834	61	0	61
1998	12	0	12	0	0	0	27	0	27	611	533	1,144	98	0	98
1999	2	0	2	0	38	38	29	0	29	133	366	499	7	0	7
2000	10	0	10	0	52	52	20	10	30	439	407	846	55	0	55
2001	32	0	32	0	903	903	49	105	154	1,174	1,464	2,638	251	9	260
2002	10	0	10	0	864	864	339	193	532	3,729	1,788	5,517	2	55	57
2003	9	0	9	0	558	558	N/A	N/A	304	N/A	N/A	5,651	N/A	N/A	446
Interim Recovery Abundance Goal			N/A			N/A			See Salmon			970			330
All Years															
Arithmetic Means	92	0	92	0	201	201	261	11	271	854	159	1,014	309	2	311
% Natural			100%			0%			96%			84%			99%
% Hatchery			0%			100%			4%			16%			1%
Mean % Goal			N/A			N/A			N/A			132%			94%
Post Listing (1999-)															
Arithmetic Means	13	0	13	0	483	483	109	77	186	1369	1006	2,375	79	16	95
% Natural			100%			0%			59%			58%			83%
% Hatchery			0%			100%			41%			42%			17%
Mean % Goal			N/A			N/A			N/A			264%			29%

Notes: Total escapement data from Kyle Adicks, WDFW, May 26, 2004.

1/ Interim recovery abundance goal for natural-origin fish from WDFW and PNPTT 2003.

2/ Hatchery origin chinook escapement includes estimated escapement to natural spawning areas and escapement to hatcheries.

3/ Hatchery and natural summer chum escapement data from WDFW and PNPTT, 2003.

7.3.2.3 Spatial Structure. The hatchery programs are benefiting spatial structure of the Salmon/Snow and Quilcene populations by increasing the numbers of naturally spawning fish, resulting in an expansion of spawning into natural areas that were vacant at lower, pre-supplementation abundance levels. Reintroduction programs are leading to range extensions for three extant populations (Quilcene, Salmon/Snow, and Union), to the benefit of ESU spatial structure. Implemented in response to the identification of moderate to high extinction risks findings, the supplementation programs have likely prevented further population extirpations in the ESU and loss of extant ESU spatial structure. All programs employ broodstock collection methods (e.g., weirs, traps, seines, or hook and line) and water intake structures in a manner that does not block or hinder access by migrating natural salmon populations to natural spawning areas. Hatchery programs that operate broodstock collection weirs are seeding upstream areas by passing all summer chum salmon not needed for use as broodstock.

7.3.2.4 Diversity. The hatchery programs have bolstered total sizes of populations that were identified as being at moderate or high risk of extinction. The programs have likely prevented harm to the genetic diversity of the populations that may have resulted if the populations were allowed to continue to decline (two to three brood years in most populations had declined to fewer than 50 adults). Extirpations and loss of total ESU diversity were prevented by hatchery supplementation programs directed at several populations, including Lilliwaup and Jimmycomelately. The reintroduction of naturally spawning summer chum populations in Big Beef and Chimacum creeks has created genetic reserves for the donor extant populations, reducing the risk of further loss of diversity in the ESU. Measures are applied through each hatchery programs to maintain genetic diversity of the natural- and hatchery-origin populations. These measures include a 12-year limit on program duration, use of only native stocks in supplementation programs, limit of donor stock use to one reintroduction, differential mass-marking of juvenile fish released from each program, and application of appropriate broodstock collection and mating protocols. Straying of hatchery summer chum into non-target watersheds has been observed. Each hatchery program includes monitoring and evaluation of performance to gauge effects on target and adjacent natural populations, including the effects of straying. Genetic analyses indicate that the programs have not adversely affected the within- or among-population genetic diversity of summer chum salmon within the ESU.

7.3.3. Artificial Propagation Record

7.3.3.1 Experience with Integrated Programs. The eight conservation-directed hatchery programs active in the ESU have been operated for four to twelve years. Two programs (Big Quilcene and Salmon Creek FH) reached their 12-year operational limit and were terminated in 2004.

7.3.3.2 Are Integrated Programs Self-sustaining. Smolt-to-adult survival rate data presented in HGMPs for several programs for which data are available indicate that the programs are operating above the replacement rate.

7.3.3.3 Certainty that Integrated Programs Will Continue to Operate. The summer chum

supplementation and reintroduction programs have fairly stable funding sources and are very certain to continue in accordance with resource management agreements and strategies. All programs operate under the *Summer Chum Salmon Conservation Initiative* (SCSCI), a proposed management framework written by WDFW and the Point No Point Treaty Tribes to preserve and restore Hood Canal summer chum salmon populations to healthy levels (WDFW and PNPTT 2000). These programs are also included as agreed strategies under the *U.S.* v. *Washington* fishery management framework. To reduce the likelihood for genetic divergence from the donor natural populations while summer chum are under artificial propagation, operation of the programs is limited to 12 years or three chum salmon generations. Two supplementation programs were terminated consistent with this measure in 2004. Monitoring and evaluation actions included in the hatchery plans support the ability to adjust the programs to meet SCSCI conservation and fish production objectives.

7.3.4. Summary of Overall Extinction Risk Faced by the ESU

The summer chum salmon hatchery programs appear to have benefited three of four VSP attributes coincident with their short period of operation. The abundance of naturally spawning summer chum salmon has been increased by the programs, as is especially evident for the Quilcene and Salmon/Snow populations and reintroduced populations in Big Beef Creek and Chimacum Creek. The contribution of the programs to the abundance of natural-origin summer chum salmon is as yet unknown. The effects of the programs on natural summer chum productivity are also unknown, although each program appears to be returning hatchery-origin adult spawners above replacement levels, as evidenced by available smolt-to-adult survival rate data. ESU spatial structure has been enhanced through increased spawning abundances and attendant density-dependent expansion of spawning area use, as well as through reintroduction of spawners in historically used watersheds. Extant diversity of the ESU has been preserved through likely prevention of further extirpations. ESU-wide diversity has benefited through creation of genetic reserves via reintroductions using extant populations. However, given the intent to terminate each hatchery program after 12 years, the viability of natural populations and extinction risk to the ESU will depend entirely on performance of natural-origin populations in their available habitat.

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